Evaluating Plant Suberin Mutants for Enhanced Water and Nutrient Uptake to Increase Biomass Production Under Elevated CO_2 Concentrations

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Spaceflight cabin environments such as the International Space Station (ISS) typically have elevated CO_2 (1500-7000 μmol mol^{-1}), which can affect plant growth and development. On earth, findings from FACE (Free-Air CO_2 Enrichment) and climate change studies have shown that plants grown at elevated (~ 700 μmol mol^{-1}) CO_2 contain reduced levels of essential elements such as nitrogen, zinc, and iron. We hypothesized that spacecraft environments with elevated CO_2 might likewise result in less nutritious crops for human consumption. Literature showed that quantitative differences in root suberin content could determine the permeability of the internal plant tissues to both water and solutes. To evaluate if there was a correlation between growth under elevated CO_2 and root suberin content we grew *Arabidopsis thaliana,* wild type (WT) (col-0), *esb1* (Enhanced Suberin 1) and *horst1* (Hydroxylase of Root Suberized Tissue) under ambient (~ 420 ± 25 μmol mol^{-1}) and elevated (800 ± 25, 1600 ± 25, 4000 ± 25 μmol mol^{-1}) CO_2 concentrations. Comparing the growth of *esb1* and *horst1* plants to WT under ambient and elevated CO_2 concentrations, *esb1* showed significantly (P-value < 0.05) lower total fresh biomass whereas the *horst1* exhibited no significant difference. RNA sequencing revealed genes related to water uptake or nutrient availability stress upregulated due to the exposure to 800 and 1600 μmol mol^{-1} CO_2. Comparing the elemental composition of leaf tissue between WT and *horst1* plants grown under elevated CO_2, we found an overall decrease in elemental composition for WT, whereas *horst1* showed an average increase of 30-60 % in the elemental contents at 1600 μmol mol^{-1} compared to plants grown at

ambient CO_2. In conclusion, our results showed that *horst1* like modification to edible crops could improve the nutritional (elemental) content to supplement astronauts's diet.